



Drainage Statement

Proposed Residential Development at

**Elizabeth Huggins Cottages
Gravesend**

On behalf of

Stonechart Developments Limited

September 2021

Document History and Status

Project Number 23504

Date	Version	Prepared By	Reviewed By	Approved By
13 Aug 2021	Draft 1.0	Steve Doughty Director	Stuart Magowan IEng MICE	Stuart Magowan IEng MICE
2 Sept 2021	1.1	Steve Doughty Director	Stuart Magowan IEng MICE	Stuart Magowan IEng MICE

This document has been prepared in accordance with the scope of services for The Civil Engineering Practice's appointment with its client and is subject to the terms of the appointment. It is addressed to and for the sole use and reliance of The Civil Engineering Practice's client. The Civil Engineering Practice accepts no liability for any use of this document other than by its client and only for the purposes, stated in the document, for which it was prepared and provided. No person other than the client may copy (in whole or in part) use or rely on the contents of this document, without the prior written permission of The Civil Engineering Practice.

Any advice, opinions, or recommendations within this document should be read and relied upon only in the context of the document as a whole. In preparing this document, information and advice may have been sought from third parties. The Civil Engineering Practice cannot be held liable for the accuracy of third party information.

The information contained within this document takes precedence over that contained within any previous version.



CONTENTS

1	Non Technical Summary	1
2	Planning Policy Context	2
2.1	National Planning Policy Framework	2
2.2	Lead Local Flood Authority	2
2.3	Local Planning Policy	3
3	Existing Site	4
3.1	Site Location	4
3.2	Site Description	4
3.3	Existing Drainage	5
3.4	Geology and Groundwater	5
4	Development Proposals	6
4.1	Description	6
4.2	Impermeable areas	6
4.3	Surface Water Drainage	6
4.4	Foul Drainage	8
4.5	Water Quality	9
5	Conclusions	10
6	List of Appendices, Images and Tables	11

1 Non Technical Summary

- 1.1 This Drainage Statement has been undertaken on behalf of Stonechart Developments Limited in support of a Planning Application for Phase 1 of a three phase development for the demolition of the existing bungalows and the construction of 34 new dwellings at Elizabeth Huggins Cottages, Gravesend, Kent.
- 1.2 The Phase 1 element of the development comprises the construction of 14 flats within a single building together with access road and parking.
- 1.3 This Statement is to be read in conjunction with all planning, architectural and other reports that accompany the Planning Application for the proposed development.
- 1.4 The proposed development will incorporate a sustainable drainage system which will discharge surface water at a suitably restricted rate to the existing surface water sewer located beneath Cross Lane West to the north of the site and provide onsite storage for all storm return periods up to and including the 1:100 year rainfall event with an allowance for climate change.
- 1.5 Foul drainage will be discharged by gravity to the existing public foul sewer located beneath Cross Lane West.
- 1.6 This report concludes that a suitable SuDS Drainage system can be provided to accommodate the anticipated flows from the proposed development.

2 Planning Policy Context

2.1 National Planning Policy Framework

2.1.1 The National Planning Policy Framework was updated in July 2021.

2.1.2 With regard to major developments the NPPF states that *'major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:*

- a) take account of advice from the lead local flood authority;*
- b) have appropriate proposed minimum operational standards;*
- c) have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and*
- d) where possible, provide multifunctional benefits'*

2.1.3 Major development is defined as follows:

'For housing, development where 10 or more homes will be provided, or the site has an area of 0.5 hectares or more. For non-residential development it means additional floorspace of 1,000m² or more, or a site of 1 hectare or more, or as otherwise provided in the Town and Country Planning (Development Management Procedure) (England) Order 2015.'

2.2 Lead Local Flood Authority

2.2.1 Kent County Council became a Lead Local Flood Authority under the Flood and Water Management Act 2010 and was given a series of new responsibilities including the role of statutory consultee for surface water management for Major Planning Applications.

2.2.2 Kent County Council note on their website that 'for all new major development it should be demonstrated that:

- an appropriate SuDS system will be incorporated (unless it is clearly demonstrated and agreed that they would be inappropriate)*
- the minimum standards of operation proposed by the applicant are appropriate*
- there are clear arrangements in place for the ongoing maintenance of any SuDS scheme over the lifetime of the associated development (through the use of planning conditions or planning obligations where appropriate).'*

2.3 Local Planning Policy

2.3.1 The Gravesham Borough Council Local Plan Core Strategy was adopted in September 2014.

2.3.2 The following policy is of specific relevance to this Drainage Statement:

2.3.3 **Policy CS18: Climate Change** states in respect of Sustainable Drainage and Surface Water Run-Off:

'The Council will seek to minimise the impact of drainage from new development on waste water systems. In particular, the Council will:

- Require that surface water run-off from all new development has, as a minimum, no greater adverse impact than the existing use; and*
- Require the use of Sustainable Drainage Systems on all developments where technically and financially feasible.'*

3 Existing Site

3.1 Site Location

3.1.1 The development site is located at Elizabeth Huggins Cottages, Cross Lane West, Gravesend, Kent, DA11 7LD.

3.1.2 The Phase 1 site is centred on Ordnance Survey reference TQ 645 727 and identified in red below.



Image 1: Site Location

3.1.3 The wider site (identified in blue above) is surrounded by residential properties and bound on its north by Cross Lane West, its south by residential garages, its west by the A227 Wrotham Road and its east by Alfred Road.

3.1.4 A copy of the site location plan is located in Appendix 1 at the rear of this report.

3.2 Site Description

3.2.1 The Phase 1 area of the site is 2,743m² in area and currently comprises 10 bungalows owned by the Ministry of Defence and operated by the Elizabeth Huggins Cottages Charity.

3.2.2 Existing ground levels are highest at the southeast corner of the site at approximately 23m AOD. The site falls towards its western corner to a level of approximately 20.9m AOD.

3.2.3 A copy of the existing site layout plan is located in Appendix 2 at the rear of this report.

3.3 Existing Drainage

- 3.3.1 Surface water and foul water from the existing properties are currently discharged in an unrestricted manner to the existing public sewers located beneath Cross Lane West to the north of the site and the A227 Wrotham Road to the west.
- 3.3.2 There is insufficient information on the sewer records to determine the depth of the existing sewers.
- 3.3.3 A copy of the sewer records is located in Appendix 3 at the rear of this report.

3.4 Geology and Groundwater

- 3.4.1 A site specific Site Investigation was undertaken by Ground and Environmental Services Limited in February 2021.
- 3.4.2 The site is underlain by sand and sandy clays to a depth of approximately 2m over structureless chalk substrata including to a depth of at least 5m.
- 3.4.3 Groundwater was not encountered within any of the onsite boreholes.
- 3.4.4 The online “Magic Map” available from Defra confirms that the site is located above a principal aquifer classified as having a high vulnerability.
- 3.4.5 The site investigation states that ‘the results of the falling head tests recorded a very high infiltration potential with rates ranging between 1.39×10^{-3} m/s and 5.2×10^{-4} m/s recorded in WS4 and WS8 respectively. Due to the very high infiltration rate in WS10 it was not possible to raise the head to quantify the infiltration rate.

Based upon these results the use of soakaways discharging into the Lewes Nodular Chalk Formation would be a viable option for disposal of surface water. It is recommended that additional DG365 testing be undertaken at enabling stage to confirm final design parameters.

Should soakaways be considered as part of the development then irrespective of other considerations they should be sited at least 10m away from any foundations. The Environment Agency and Local Authority must be consulted when planning soakaway installations.’

- 3.4.6 Extracts from the Site Investigation are located in Appendix 4 at the rear of this report.

4 Development Proposals

4.1 Description

4.1.1 The development proposals are for the demolition of the existing bungalows in phases and construction of 34 new dwellings in phases at Cross Lane West.

4.1.2 The Phase 1 development is for the demolition of three of the bungalows and their garages and the construction of a single building comprising 14 flats together with access road and car parking for 12 vehicles.

4.2 Impermeable areas

4.2.1 The impermeable areas of the various elements of the Phase 1 development are summarised as follows:

- Roof Area 733m²
- Access Road and Parking Area 649m²

4.2.2 A copy of the proposed site layout plan is located in Appendix 5 at the rear of this report.

4.3 Surface Water Drainage

4.3.1 CIRIA report C753 The SuDS Manual-v6 provides guidance on surface water drainage. The aim for surface water runoff is to match greenfield runoff rates and volumes where reasonably achievable.

4.3.2 For surface water discharge, the drainage hierarchy notes the following list of drainage options in order of preference:

- 1 Infiltration to ground
- 2 Discharge to a watercourse
- 3 Discharge to a surface water sewer
- 4 Discharge to a foul water sewer

4.3.3 The preferred surface water drainage strategy should where possible be based on infiltration to ground.

4.3.4 The geology of the area is free draining, however, concern has been raised within the Site Investigation in respect of the potential for infiltration in this locality to affect foundations. A 10m exclusion zone has been recommended around the proposed buildings.

4.3.5 With this constraint there is no area of the site which can suitably be used for infiltration.

- 4.3.6 Furthermore the structureless nature of the chalk substrata is characteristic of chalks liable to solution features and infiltration in such material is inherently subject to a relatively high level of risk.
- 4.3.7 The proposed surface water drainage strategy will therefore be based on a restricted discharge to the existing public surface water sewer beneath Cross Lane West adjacent to the northwest corner of the site mimicking the pre developed greenfield runoff of the Phase 1 site.
- 4.3.8 Pre-developed greenfield runoff rates have been established using the HR Wallingford tool for Greenfield runoff estimation.



HR Wallingford
Working with water

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:

Site name:

Site location:

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013), the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:

Longitude:

Reference:

Date:

Runoff estimation approach

Site characteristics

Total site area (ha):

Methodology

Q_{BAR} estimation method:

SPR estimation method:

Soil characteristics

	Default	Edited
SOIL type:	3	3
HOST class:	N/A	N/A
SPR/SPRHOST:	0.37	0.37

Hydrological characteristics

	Default	Edited
SAAR (mm):	576	576
Hydrological region:	7	7
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Growth curve factor 200 years:	3.74	3.74

Notes

(1) Is $Q_{BAR} < 2.0$ l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is $SPR/SPRHOST \leq 0.3$?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	2.29	2.29
1 in 1 year (l/s):	1.94	1.94
1 in 30 years (l/s):	5.26	5.26
1 in 100 years (l/s):	7.29	7.29
1 in 200 years (l/s):	8.55	8.55

This report was produced using the greenfield runoff tool developed by HR Wallingford and available at www.uksuds.com. The use of this tool is subject to the UKSuds terms and conditions and license agreement, which can both be found at www.uksuds.com/terms-and-conditions.htm. The outputs from this tool are estimates of greenfield runoff rates. The use of these results is the responsibility of the user of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrocology or any of the organisations for the use of this data in the design or operational characteristics of any drainage scheme.

Image 2: Greenfield Runoff Calculation

4.3.9 The pre-developed greenfield runoff rates are as follows:

- Q_{bar} 2.29 l/s/ha
- 1:100 year 7.28 l/s/ha

4.3.10 The total impermeable area of the Phase 1 site will be approximately 1,382m². The equivalent Q_{bar} greenfield runoff is 0.32l/s and the Q_{100} runoff is 1l/s.

4.3.11 Such low levels of restriction are impractical and HR Wallingford guidance recommends a maximum restriction of 5l/s. Rates of 2l/s are however now achievable.

4.3.12 Preliminary calculations have been prepared in order to demonstrate that surface water drainage can be restricted to 2l/s and attenuated beneath the permeable paving used for the access and parking areas.

4.3.13 Given the site levels this is proposed within a voided crate storage system at the western side of the site with the permeable paving above providing surface water treatment.

4.3.14 As previously noted there is insufficient information on the sewer records to determine the depth of the existing sewers. In order to allow a preliminary design a depth to invert of the sewers to the west of the Phase 1 site has been assumed at 1.2m below carriageway level. This will require further investigation to confirm the detailed design.

4.3.15 The storage has been sized to accommodate a 1:100 year storm event including an additional 40% to account for the predicted effects of future climate change.

4.3.16 A total storage volume of 103m³ is required. The preliminary storage design for an 800mm deep 95% voided crate system (two layers). This requires a total of 536 crates spanning an area of 134m².

4.4 Foul Drainage

4.4.1 Foul drainage will be discharged by gravity to the existing public foul sewers located beneath Cross Lane West and if possible via an existing onsite connection.

4.4.2 The existing foul drainage from the area of the wider site to the south of the proposed development site will require diversion. Confirmation of invert levels will be required to confirm the detail but it is anticipated that this will be adjacent to the eastern and northern site boundaries.

4.4.3 Copies of the preliminary drainage strategy plan and calculations are located in Appendix 6 at the rear of this report.

4.5 Water Quality

4.5.1 The proposed development is for residential use. In accordance with CIRIA SuDS Manual 2015 (Report C753), the pollution hazard level for this type of development is between very low and low depending on the use / area of the site.

4.5.2 The surface water scheme will include mitigation to ensure that surface water is suitably treated and any pollution risk adequately managed prior to discharge.

4.5.3 Table 26.2 in Chapter 26 of CIRIA report C753 The SuDS Manual provides Pollution Hazard Indices for varying land types. Those of relevance to the development proposals are as follows:

Land Use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydrocarbons
Residential roofs	Very Low	0.2	0.2	0.05
Individual property driveways, residential car park, low-traffic roads	Low	0.5	0.4	0.4

Table 1: Pollution Hazard Indices

4.5.4 The use of permeable paving will meet the target treatment level required

SuDS Type	Total suspended solids (TSS)	Metals	Hydrocarbons
Permeable pavement	0.7	0.6	0.7

Table 2: Pollution Mitigation Indices

4.5.5 An outline drainage maintenance schedule is located in Appendix 7 at the rear of this report.

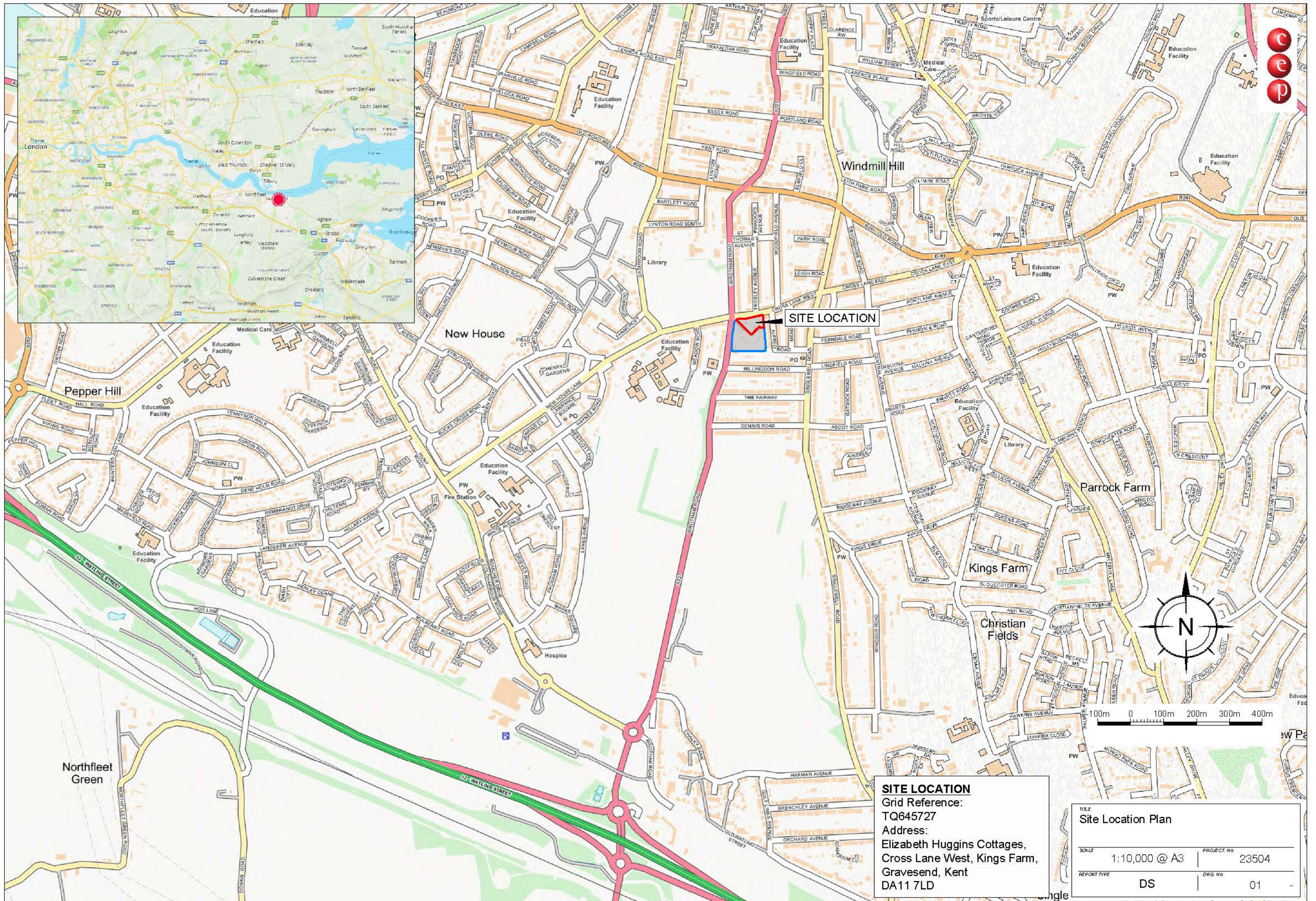
5 Conclusions

- 5.1 The geology of the area is free draining but concern has been raised within the Site Investigation in respect of the potential for infiltration in this locality to affect foundations. A 10m exclusion zone has been recommended around the proposed buildings which results in there being no suitable area available for infiltration.
- 5.2 Furthermore the structureless nature of the chalk substrata is characteristic of chalks liable to solution features.
- 5.3 A suitable SuDS drainage system can however be provided which accords with the requirements of national and local policy and discharge surface water to the existing public surface water sewers at a greatly reduced rate than the existing runoff.
- 5.4 Preliminary calculations indicate that surface water runoff generated by the proposed development can be attenuated on site for all rainfall events up to the 1:100 year event including an allowance for climate change.
- 5.5 Water quality improvement will be provided to mitigate against any risk to any receiving waterbody.
- 5.6 Foul drainage will be discharged by gravity to the existing public foul sewer located beneath Cross Lane West.

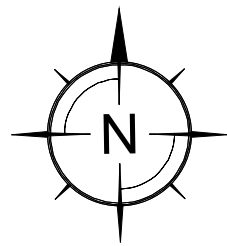
6 List of Appendices, Images and Tables

Appendix 1	Site Location Plan
Appendix 2	Existing Site Layout Plan
Appendix 3	Sewer Records
Appendix 4	Extracts from the Site Investigation
Appendix 5	Proposed Site Layout Plan
Appendix 6	Preliminary Drainage Strategy Plan and Calculations
Appendix 7	Outline Drainage Maintenance Schedule
Image 1	Site Location
Image 2	Greenfield Runoff Calculation
Table 1	Pollution Hazard Indices
Table 2	Pollution Mitigation Indices

Appendix 1
Site Location Plan



Appendix 2
Existing Site Layout Plan



-5m 0 5 10 15 20m

Phase 1
Phases 2 and 3

CROSS LANE WEST

cep



Wider Site Plan
1:2,000

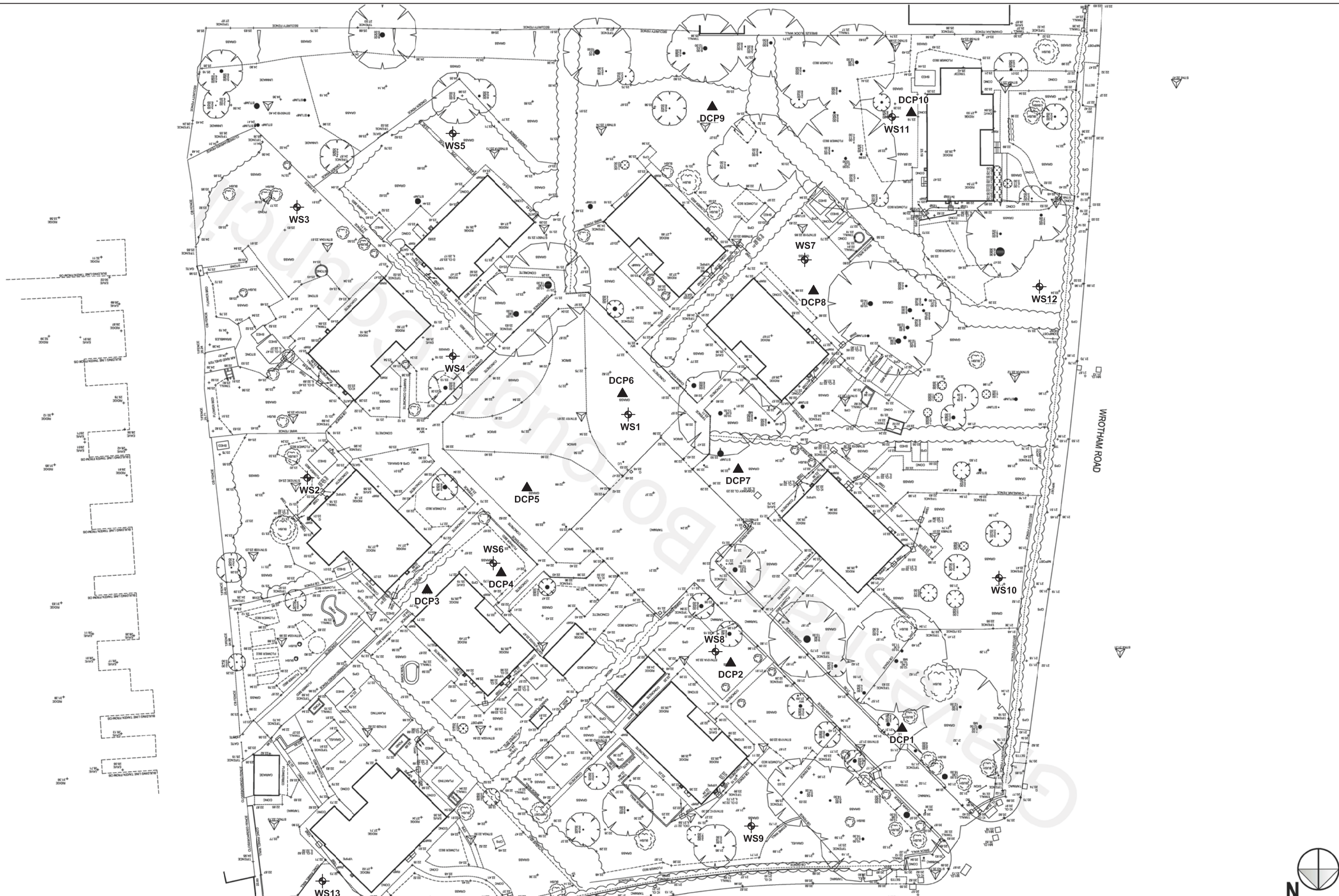
TITLE
Existing Site Layout Plan

SCALE	1:250 @ A3	PROJECT No.	23504
REPORT TYPE	DS	DRG. No.	02

Appendix 3
Sewer Records

Appendix 4

Extracts from the Site Investigation



EXISTING SITE PLAN, 1:200@A0

WS - Window Sample	DP - Dynamic Probe
BH - Borehole	GM - Gas Monitoring Standpipe
TP - Trial Pit	SP - Soakage Pit
HDTP - Hand Dug Trial Pit	PT - Percolation Test
DCP - Dynamic Cone Penetration Test	S - Sample Location
HA - Hand Auger	

Site: Elizabeth Huggins Cottages, Gravesend

Title: Figure 1 Exploratory Hole Location Plan

Client: Stonechart Developments

Project: 12545

Drawn: PJ

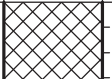
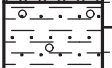
Date: 12/2020

Rev.:

Scale:



Unit 2 Montpelier
Business Park,
Dencora Way,
Ashford,
Kent TN23 4FG
Tel: 01233 646 237

 Ground and Environmental Services Limited Unit 2 Montpelier Business Park Dencora Way, Ashford Kent TN23 4FG Tel: 01233 646237					Window Sampler Log No. WS06 Sheet: 1 of 1						
Equipment & Methods. Premier 110 Compact Support Used:None Backfill: Arisings					Project Name: Elizabeth Huggins Cottages Project Location: Cross Lane West, Gravesend DA11 7LD Client: Elizabeth Huggins Trust					Job No: 12545	
Co-ordinates: E: N:					Ground Level (m):		Date Started: 16/12/2020 Date Completed: 16/12/2020				
Samples and In situ Testing				Field Records	DESCRIPTION	Reduced Level (m)	Legend	Depth (Thick) (m)			
Depth (m)	No.	Type	Result								
0.30		TUB			MADE GROUND: dark brown sandy clayey silt, Occasional chalk and flint fragments. frequent roots			(0.40)			
0.50- 0.60		D			Firm orangeish brown gravelly sandy CLAY, Gravel is fine to medium sub rounded to angular flint (Head)	-0.40		0.40 (0.35)			
0.90- 1.00		D			Loose orangeish brown slightly clayey SAND, Sand is fine to medium (Head)	-0.75		0.75 (0.25)			
1.00- 1.45		SPTLS	SN=9	1,1/2,2,2,3	Firm greenish brown and orange silty very sandy CLAY, Sand is fine to medium (Head)	-1.00		1.00 (0.30)			
1.50- 1.60		D			Firm greenish grey with orange very sandy SILT, Sand is fine. friable. fine roots to 1.7m (Head)	-1.30		1.30 (0.60)			
2.00- 2.45		SPTLS	SN=9	1,2/2,2,2,3	White with orangeish white partially weathered CHALK, Chalk recovered as structureless melange comprising fine to medium gravel in a silt matrix grade Dc (Lewes Nodular Chalk Formation)	-1.90		1.90			
2.50- 2.70		D			...from 2.50 flint gravel						
3.00- 3.45		SPTLS	SN=6	1,1/1,2,1,2							
3.70- 3.90		D									
4.00- 4.45		SPTLS	SN=11	1,2/2,3,3,3							
4.70- 4.90											
			CN=14	2,3/3,4,3,4							
						-5.00		5.00			
						End of W/S 5.00 m (Thickness of basal layer not proven)					
Remarks:						Logged By: CS		Checked By:			
						Scale: 1:30		Approved By:			
						FIG No.					
Notes: For explanation of symbols and abbreviations, see Key Sheet.											



Ground and Environmental Services Limited

Unit 2 Montpelier Business Park
Dencora Way, Ashford
Kent TN23 4FG

Tel: 01233 646237

Window Sampler Log No. WS08

Sheet: 1 of 1

Equipment & Methods. Premier 110 Compact Support Used:None Backfill: 35mm Standpipe Installation				Project Name: Elizabeth Huggins Cottages Project Location: Cross Lane West, Gravesend DA11 7LD Client: Elizabeth Huggins Trust		Job No: 12545		
Co-ordinates: E: N:				Ground Level (m):		Date Started:17/12/2020 Date Completed:17/12/2020		
Samples and In situ Testing				Field Records	DESCRIPTION	Reduced Level (m)	Legend	Depth (Thick) (m)
Depth (m)	No.	Type	Result					
0.30		TUB			MADE GROUND: dark brown sandy clayey silt, Occasional flint fragments. rare carbon and brick fragments. frequent roots	-0.45		(0.45)
0.60- 0.70		D			Firm orangeish brown silty sandy CLAY, Occasional gravel of fine to medium sub rounded to angular flint. roots up to 20mm diameter to 0.6m. fine roots upto 1mm diameter to 1.2m (Head)	-1.30		0.45 (0.85)
1.00- 1.45		SPTLS	SN=13	1,1/2,3,4,4	Stiff light brown with white gravelly sandy SILT, Sand is fine. friable. gravel is fine to medium chalk and occasional flint (Head)	-2.10		1.30 (0.80)
1.40- 1.50		D			...from 1.95 to 2.10 much flint gravel			2.10
2.00- 2.45		SPTLS	SN=13	4,6/5,3,2,3	White with orangeish white partially weathered CHALK, Chalk recovered as structureless melange comprising fine to medium gravel in a silt matrix grade Dc (Lewes Nodular Chalk Formation)			
2.50- 2.70		D						
3.00- 3.45		SPTLS	SN=5	1,1/1,1,2,1				
3.60- 3.80		D						(2.90)
4.00- 4.45		SPTLS	SN=12	2,2/2,3,3,4				
4.70- 4.90		D						
			CN=8	1,2/2,2,2,2		-5.00		5.00
Remarks:						Logged By:		Checked By:
						CS		
						Scale: 1:30		Approved By:
Notes: For explanation of symbols and abbreviations, see Key Sheet.						FIG No.		



Ground and Environmental Services Limited

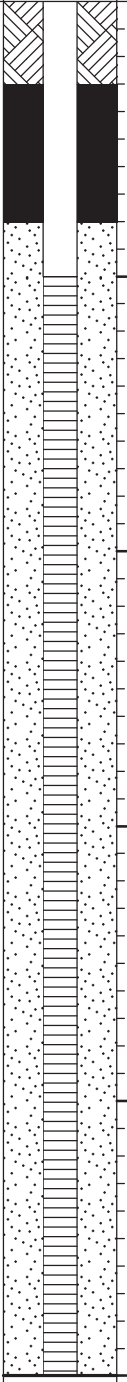
Unit 2 Montpelier Business Park
Dencora Way, Ashford
Kent TN23 4FG

T: 01233 646237

Hole ID. WS08

Installation Details & Readings

Sheet: 1 of 1

Equipment & Methods. Premier 110 Compact Support Used:None Backfill: 35mm Standpipe Installation		Project Name: Elizabeth Huggins Cottages Project Location: Cross Lane West, Gravesend DA11 7LD Client: Elizabeth Huggins Trust		Job No: 12545	
Co-ordinates: E: N:		Ground Level (m):		Date Started: 17/12/2020 Date Completed: 17/12/2020	
Installation Date : 17/12/2020 Depth to TOP Response Zone : 1 (m) Installation Type : SP Depth to BASE Response Zone : 5 (m)				Installation Diagram	
					
				flush cover with gas tap 0.3	
				Bentonite 0.8	
				1 (-1.00)	
				slotted standpipe with gravel annulus	
End of Hole 5.00 m (-5.00)					
Notes: For explanation of symbols and abbreviations, see Key Sheet.				Compiled By: CS	
				Scale:	
				FIG No.	
				Checked By:	
				Approved By:	



Ground and Environmental Services Limited

Unit 2 Montpelier Business Park
Dencora Way, Ashford
Kent TN23 4FG

Tel: 01233 646237

Window

Sampler Log No. WS09

Sheet: 1 of 1

Equipment & Methods. Premier 110 Compact Support Used:None Backfill: Arisings				Project Name: Elizabeth Huggins Cottages Project Location: Cross Lane West, Gravesend DA11 7LD Client: Elizabeth Huggins Trust		Job No: 12545		
Co-ordinates: E: N:				Ground Level (m):		Date Started:17/12/2020 Date Completed:17/12/2020		
Samples and In situ Testing				Field Records	DESCRIPTION	Reduced Level (m)	Legend	Depth (Thick) (m)
Depth (m)	No.	Type	Result					
0.30		TUB			MADE GROUND: dark brown sandy clayey silt, Occasional flint fragments. rare carbon fragments. frequent roots			(0.50)
0.50- 0.60		D			Firm orangeish brown silty sandy CLAY, Rare gravel of fine to medium sub rounded to angular flint. fine roots upto 1mm diameter to 1.1m (Head)	-0.50		0.50
1.10- 1.20 1.00- 1.45		D SPTLS	SN=12	1,1/1,2,4,5	Stiff light brown with white gravelly sandy SILT, Sand is fine. friable. gravel is fine to medium chalk and occasional flint (Head)	-1.30		1.30
1.70- 1.80		D			...from 1.90 to 2.00 abundant flints	-2.10		2.10
2.00- 2.45		SPTLS	SN=30	4,6/8,9,7,6	White with orangeish white partially weathered CHALK, Chalk recovered as structureless melange comprising fine to medium gravel in a silt matrix grade Dc (Lewes Nodular Chalk Formation)			
2.60- 2.80		D						
3.00- 3.45		SPTLS	SN=8	1,2/2,2,2,2				
3.60- 3.80		D						(2.90)
4.00- 4.45		SPTLS	SN=9	1,2/2,2,2,3				
4.70- 4.90		D						
			CN=17	2,2/3,7,4,3		-5.00		5.00
						End of W/S 5.00 m (Thickness of basal layer not proven)		
Remarks:						Logged By:		Checked By:
						CS		
						Scale: 1:30		Approved By:
						FIG No.		
Notes: For explanation of symbols and abbreviations, see Key Sheet.								



Ground and Environmental Services Limited

Unit 2 Montpelier Business Park
Dencora Way, Ashford
Kent TN23 4FG

Tel: 01233 646237

Window Sampler Log No. WS13

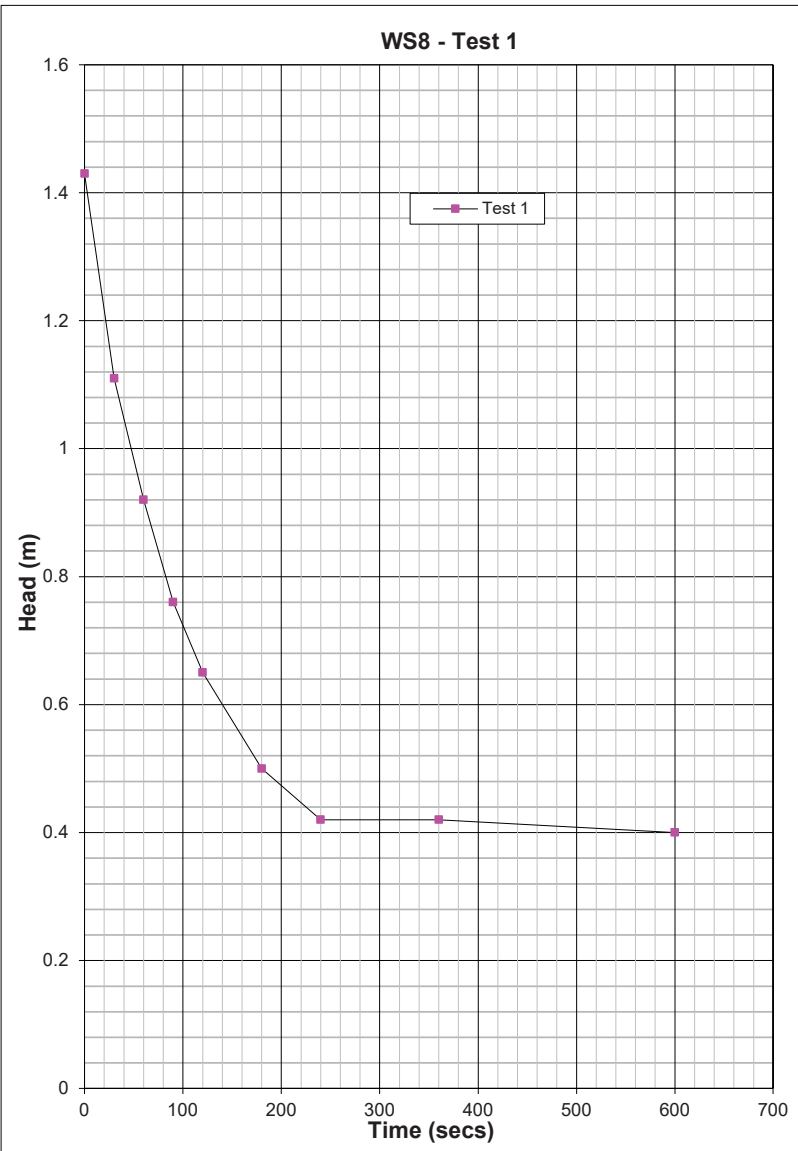
Sheet: 1 of 1

Equipment & Methods. Premier 110 Compact Support Used:None Backfill: Arisings					Project Name: Elizabeth Huggins Cottages Project Location: Cross Lane West, Gravesend DA11 7LD Client: Elizabeth Huggins Trust			Job No: 12545			
Co-ordinates: E: N:					Ground Level (m):			Date Started: 17/12/2020 Date Completed: 17/12/2020			
Samples and In situ Testing				Field Records	DESCRIPTION	Reduced Level (m)	Legend	Depth (Thick) (m)			
Depth (m)	No.	Type	Result								
0.30		TUB			MADE GROUND: dark brown sandy clayey silt, Occasional flint fragments. rare carbon and brick fragments. frequent roots	-0.35		(0.35)			
0.60- 0.70		D			Soft to firm orangeish brown silty very sandy CLAY, Rare fine gravel of flint.			0.35			
1.00- 1.45 1.20- 1.30		SPTLS D	SN=2	0,0/0,1,0,1	...from 1.40 becoming firm			(1.75)			
1.90- 2.00		D				-2.10		2.10			
2.00- 2.45		SPTLS	SN=12	1,2/2,3,3,4	Stiff light brown with white gravelly sandy SILT, Sand is fine. friable. gravel is fine to medium chalk and occasional flint			(0.70)			
2.50- 2.70		D			...from 2.70 coarse flint gravel	-2.80		2.80			
3.00- 3.45		SPTLS	SN=5	1,1/1,2,1,1	White with orangeish white partially weathered CHALK, Chalk recovered as structureless melange comprising fine to medium gravel in a silt matrix grade Dc						
3.60- 3.80		D						(2.20)			
4.00- 4.45		SPTLS	SN=9	1,2/2,2,2,3							
4.70- 4.90		D									
			CN=12	1,2/3,3,3,3		-5.00		5.00			
Remarks:						End of W/S 5.00 m (Thickness of basal layer not proven)					
						Logged By: CS			Checked By:		
						Scale: 1:30			Approved By:		
Notes: For explanation of symbols and abbreviations, see Key Sheet.						FIG No.					

[illegible]

	Elizabeth Huggins Cottages						WS 8		
Top section		1		m	Centre section		3		m
Bottom section		5		m	Diameter of test section		0.035		m
Water Level		dry		m	Diameter of Hole		0.035		m
					Length of test section		4		m

Time (Seconds)	Depth	Head
0	3.57	1.43
30	3.89	1.11
60	4.08	0.92
90	4.24	0.76
120	4.35	0.65
180	4.5	0.5
240	4.58	0.42
360	4.58	0.42
600	4.6	0.4

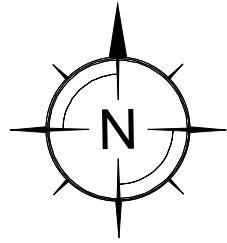


Very good soakage - 25L of water added in 50 secs - Unable to raise head fully

After BS5930:1999 k(approx) = 5.2 x 10⁻⁴ m/s

[illegible]

Appendix 5
Proposed Site Layout Plan



-2.5m 0 2.5m 5.0m 7.5m 10m

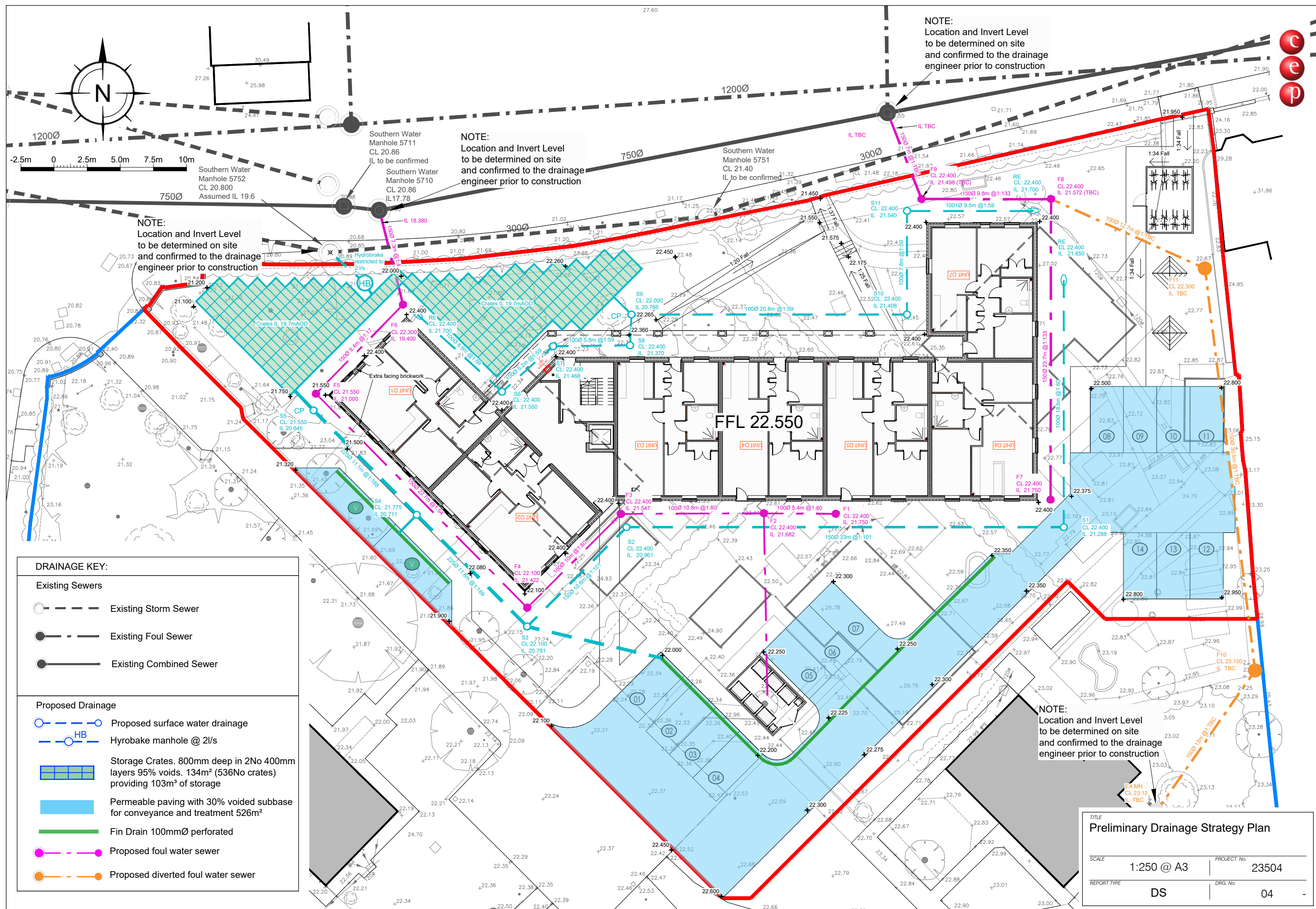
CROSS LANE WEST

c
e
p



Appendix 6

Preliminary Drainage Strategy Plan and Calculations



Design Settings

Rainfall Methodology	FEH-13	Minimum Velocity (m/s)	1.00
Return Period (years)	2	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.200
CV	0.850	Preferred Cover Depth (m)	0.600
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	✓
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
RE1	0.009	5.00	22.400	250	564555.194	172765.802	0.750
S1	0.009	5.00	22.400	450	564555.194	172747.236	1.112
S2	0.005	5.00	22.400	450	564522.243	172747.236	1.439
S3	0.061	5.00	22.100	450	564514.755	172739.748	1.319
S4	0.013	5.00	21.775	450	564506.444	172748.166	1.064
S5	0.005	5.00	21.550	450	564498.670	172756.031	0.905
S5 Crates	0.000	5.00	21.550		564497.216	172757.503	0.918
RE2	0.005	5.00	22.400	250	564506.529	172763.211	0.700
S6	0.005	5.00	22.400	480	564512.872	172757.436	0.845
S7	0.000		22.400	480	564516.716	172760.867	0.932
S8	0.005	5.00	22.400	1050	564522.512	172760.928	1.030
S9	0.000		22.300	1050	564522.613	172763.252	1.148
S10	0.014	5.00	22.400	1050	564543.379	172763.252	1.042
S11	0.005	5.00	22.400	480	564543.379	172771.057	0.860
RE3	0.005	5.00	22.400	250	564552.872	172771.057	0.700
S9 Crates	0.000	5.00	22.400		564521.400	172764.687	1.373
Hydrobrake	0.000		21.900	1200	564502.542	172765.622	2.200
Public Sewer			20.800	1200	564499.923	172767.918	1.200

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	RE1	S1	18.566	0.600	21.650	21.338	0.312	59.5	100	5.31	50.0
1.001	S1	S2	32.951	0.600	21.288	20.961	0.327	100.8	150	5.86	50.0
1.002	S2	S3	10.590	0.600	20.961	20.856	0.105	100.9	150	6.03	50.0
1.003	S3	S4	11.829	0.600	20.781	20.711	0.070	169.0	225	6.23	50.0
1.004	S4	S5	11.059	0.600	20.711	20.645	0.066	167.6	225	6.41	50.0
1.005	S5	S5 Crates	2.069	0.600	20.645	20.632	0.013	159.2	225	6.45	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	1.000	7.9	1.4	0.650	0.962	0.009	0.0	29	0.754
1.001	1.001	17.7	2.8	0.962	1.289	0.018	0.0	40	0.731
1.002	1.000	17.7	3.5	1.289	1.094	0.023	0.0	45	0.782
1.003	1.003	39.9	12.9	1.094	0.839	0.084	0.0	87	0.895
1.004	1.007	40.0	14.9	0.839	0.680	0.097	0.0	95	0.936
1.005	1.034	41.1	15.7	0.680	0.693	0.102	0.0	96	0.965

	The Civil Engineering Practice			File: Preliminary Surface Water.pfd				Page 2			
	BN41 1RA			Network: Storm Network				23504			
	www.civil.co.uk			Steve Doughty				Elizabeth Huggins Cottages			
	reception@civil.co.uk			02/09/2021				Preliminary Surface Water			
Links											
Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
2.000	RE3	S11	9.493	0.600	21.700	21.540	0.160	59.3	100	5.16	50.0
2.001	S11	S10	7.805	0.600	21.540	21.408	0.132	59.1	100	5.29	50.0
2.002	S10	S9	20.766	0.600	21.358	21.152	0.206	100.8	150	5.63	50.0
3.000	RE2	S6	8.578	0.600	21.700	21.555	0.145	59.2	100	5.14	50.0
3.001	S6	S7	5.152	0.600	21.555	21.468	0.087	59.2	100	5.23	50.0
3.002	S7	S8	5.796	0.600	21.468	21.370	0.098	59.1	100	5.32	50.0
3.003	S8	S9	2.326	0.600	21.370	21.202	0.168	13.8	100	5.34	50.0
3.004	S9	S9 Crates	1.879	0.600	21.152	21.027	0.125	15.0	150	5.65	50.0
Crates Dummy 1	S5 Crates	Hydrobrake	9.710	0.600	20.632	19.700	0.932	10.4	225	6.49	49.9
Crates Dummy 2	S9 Crates	Hydrobrake	18.881	0.600	21.027	19.700	1.327	14.2	150	5.76	50.0
Outfall	Hydrobrake	Public Sewer	3.483	0.600	19.700	19.600	0.100	34.8	225	6.51	49.8
Pipeline Schedule											
Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)	
1.000	18.566	59.5	100	Circular	22.400	21.650	0.650	22.400	21.338	0.962	
1.001	32.951	100.8	150	Circular	22.400	21.288	0.962	22.400	20.961	1.289	
1.002	10.590	100.9	150	Circular	22.400	20.961	1.289	22.100	20.856	1.094	
1.003	11.829	169.0	225	Circular	22.100	20.781	1.094	21.775	20.711	0.839	
1.004	11.059	167.6	225	Circular	21.775	20.711	0.839	21.550	20.645	0.680	
1.005	2.069	159.2	225	Circular	21.550	20.645	0.680	21.550	20.632	0.693	
Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type			
1.000	RE1	250	Manhole	Private	S1	450	Manhole	Private			
1.001	S1	450	Manhole	Private	S2	450	Manhole	Private			
1.002	S2	450	Manhole	Private	S3	450	Manhole	Private			
1.003	S3	450	Manhole	Private	S4	450	Manhole	Private			
1.004	S4	450	Manhole	Private	S5	450	Manhole	Private			
1.005	S5	450	Manhole	Private	S5 Crates		Junction				
Flow+ v10.1 Copyright © 1988-2021 Causeway Technologies Ltd											

Pipeline Schedule

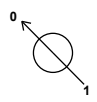
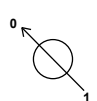
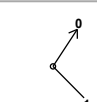
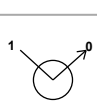
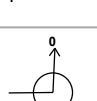
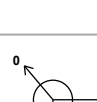
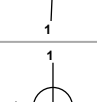
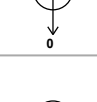
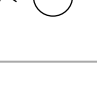
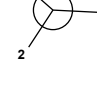
Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
2.000	9.493	59.3	100	Circular	22.400	21.700	0.600	22.400	21.540	0.760
2.001	7.805	59.1	100	Circular	22.400	21.540	0.760	22.400	21.408	0.892
2.002	20.766	100.8	150	Circular	22.400	21.358	0.892	22.300	21.152	0.998
3.000	8.578	59.2	100	Circular	22.400	21.700	0.600	22.400	21.555	0.745
3.001	5.152	59.2	100	Circular	22.400	21.555	0.745	22.400	21.468	0.832
3.002	5.796	59.1	100	Circular	22.400	21.468	0.832	22.400	21.370	0.930
3.003	2.326	13.8	100	Circular	22.400	21.370	0.930	22.300	21.202	0.998
3.004	1.879	15.0	150	Circular	22.300	21.152	0.998	22.400	21.027	1.223
Crates Dummy 1	9.710	10.4	225	Circular	21.550	20.632	0.693	21.900	19.700	1.975
Crates Dummy 2	18.881	14.2	150	Circular	22.400	21.027	1.223	21.900	19.700	2.050
Outfall	3.483	34.8	225	Circular	21.900	19.700	1.975	20.800	19.600	0.975

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
2.000	RE3	250	Manhole	Private	S11	480	Manhole	Private
2.001	S11	480	Manhole	Private	S10	1050	Manhole	Private
2.002	S10	1050	Manhole	Private	S9	1050	Manhole	Private
3.000	RE2	250	Manhole	Private	S6	480	Manhole	Private
3.001	S6	480	Manhole	Private	S7	480	Manhole	Private
3.002	S7	480	Manhole	Private	S8	1050	Manhole	Private
3.003	S8	1050	Manhole	Private	S9	1050	Manhole	Private
3.004	S9	1050	Manhole	Private	S9 Crates		Junction	
Crates Dummy 1	S5 Crates		Junction		Hydrobrake	1200	Manhole	Private
Crates Dummy 2	S9 Crates		Junction		Hydrobrake	1200	Manhole	Private
Outfall	Hydrobrake	1200	Manhole	Private	Public Sewer	1200	Manhole	Private

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)	
RE1	564555.194	172765.802	22.400	0.750	250		0	1.000	21.650	100
S1	564555.194	172747.236	22.400	1.112	450		1	1.000	21.338	100
							0	1.001	21.288	150
S2	564522.243	172747.236	22.400	1.439	450		1	1.001	20.961	150
							0	1.002	20.961	150
S3	564514.755	172739.748	22.100	1.319	450		1	1.002	20.856	150
							0	1.003	20.781	225

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
S4	564506.444	172748.166	21.775	1.064	450		1 1.003	20.711	225
S5	564498.670	172756.031	21.550	0.905	450		0 1.004 1 1.004	20.711 20.645	225 225
S5 Crates	564497.216	172757.503	21.550	0.918			0 1.005 1 1.005	20.645 20.632	225 225
RE2	564506.529	172763.211	22.400	0.700	250		0 3.000	21.700	100
S6	564512.872	172757.436	22.400	0.845	480		1 3.000	21.555	100
S7	564516.716	172760.867	22.400	0.932	480		0 3.001 1 3.001	21.555 21.468	100 100
S8	564522.512	172760.928	22.400	1.030	1050		0 3.002 1 3.002	21.468 21.370	100 100
S9	564522.613	172763.252	22.300	1.148	1050		0 3.003 1 3.003 2 2.002	21.370 21.202 21.152	100 100 150
S10	564543.379	172763.252	22.400	1.042	1050		0 3.004 1 2.001	21.152 21.408	150 100
S11	564543.379	172771.057	22.400	0.860	480		0 2.002 1 2.000	21.358 21.540	150 100
RE3	564552.872	172771.057	22.400	0.700	250		0 2.001	21.540	100
S9 Crates	564521.400	172764.687	22.400	1.373			0 2.000 1 3.004	21.700 21.027	100 150
Hydrobrake	564502.542	172765.622	21.900	2.200	1200		0 Crates Dummy 2 1 Crates Dummy 2 2 Crates Dummy 1	21.027 19.700 19.700	150 150 225
							0 Outfall	19.700	225

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
Public Sewer	564499.923	172767.918	20.800	1.200	1200	1	Outfall	19.600	225
									

Simulation Settings

Rainfall Methodology	FEH-13	Analysis Speed	Normal	Additional Storage (m³/ha)	20.0
Summer CV	0.850	Skip Steady State	x	Check Discharge Rate(s)	x
Winter CV	0.900	Drain Down Time (mins)	2160	Check Discharge Volume	x

Storm Durations

15 | 30 | 60 | 120 | 180 | 240 | 360 | 480 | 600 | 720 | 960 | 1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
100	40	0	0

Node Hydrobrake Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	19.700	Product Number	CTL-SHE-0060-2000-1600-2000
Design Depth (m)	1.600	Min Outlet Diameter (m)	0.075
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node Hydrobrake Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	19.700
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	808

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	134.0	0.0	0.800	134.0	0.0	0.801	0.0	0.0

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.68%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	RE1	12	21.855	0.205	7.2	0.0592	0.0000	SURCHARGED
15 minute summer	S1	11	21.647	0.359	13.6	0.1152	0.0000	SURCHARGED
15 minute summer	S2	11	21.488	0.527	15.7	0.1206	0.0000	SURCHARGED
15 minute summer	S3	11	21.389	0.608	61.4	0.6591	0.0000	SURCHARGED
360 minute winter	S4	352	21.363	0.652	11.2	0.2628	0.0000	SURCHARGED
360 minute winter	S5	352	21.363	0.718	11.8	0.1938	0.0000	FLOOD RISK
360 minute winter	S5 Crates	352	21.362	0.730	11.8	0.0000	0.0000	FLOOD RISK
15 minute summer	RE2	10	21.750	0.050	4.0	0.0096	0.0000	OK
15 minute summer	S6	11	21.670	0.115	8.0	0.0345	0.0000	SURCHARGED
15 minute summer	S7	11	21.560	0.092	7.6	0.0167	0.0000	OK
15 minute summer	S8	11	21.449	0.079	11.4	0.0764	0.0000	OK
360 minute winter	S9	352	21.362	0.210	4.6	0.1819	0.0000	SURCHARGED
15 minute summer	S10	11	21.513	0.155	18.8	0.1756	0.0000	SURCHARGED
15 minute summer	S11	11	21.653	0.113	8.0	0.0337	0.0000	SURCHARGED
15 minute summer	RE3	10	21.750	0.050	4.0	0.0096	0.0000	OK
360 minute winter	S9 Crates	352	21.362	0.335	4.6	0.0000	0.0000	SURCHARGED
360 minute winter	Hydrobrake	352	21.362	1.662	16.4	103.7832	0.0000	SURCHARGED
15 minute summer	Public Sewer	1	19.600	0.000	1.5	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	RE1	1.000	S1	6.5	1.085	0.821	0.1453	
15 minute summer	S1	1.001	S2	13.4	0.880	0.756	0.5801	
15 minute summer	S2	1.002	S3	18.8	1.068	1.064	0.1864	
15 minute summer	S3	1.003	S4	61.4	1.544	1.540	0.4705	
360 minute winter	S4	1.004	S5	11.2	0.830	0.279	0.4398	
360 minute winter	S5	1.005	S5 Crates	11.8	1.347	0.287	0.0823	
360 minute winter	S5 Crates	Crates Dummy 1	Hydrobrake	11.8	1.885	0.073	0.3862	
15 minute summer	RE2	3.000	S6	4.0	0.659	0.503	0.0504	
15 minute summer	S6	3.001	S7	7.6	1.010	0.967	0.0396	
15 minute summer	S7	3.002	S8	7.6	1.089	0.963	0.0412	
15 minute summer	S8	3.003	S9	11.4	1.934	0.696	0.0136	
360 minute winter	S9	3.004	S9 Crates	4.6	1.602	0.100	0.0331	
15 minute summer	S10	2.002	S9	18.3	1.204	1.034	0.3185	
15 minute summer	S11	2.001	S10	7.7	1.055	0.973	0.0611	
15 minute summer	RE3	2.000	S11	4.0	0.682	0.504	0.0554	
360 minute winter	S9 Crates	Crates Dummy 2	Hydrobrake	4.6	1.434	0.097	0.3324	
360 minute winter	Hydrobrake	Hydro-Brake®	Public Sewer	2.0				139.4

Appendix 7

Outline Drainage Maintenance Schedule

Drainage Maintenance Schedule



Project	Elizabeth Huggins Cottages, Gravesend
Project Number	23504

By Steve Doughty

Date 11 August 2021

1 Schedule of Maintenance

- 1.1 Once appointed the Contractor will prepare a site specific method statement for the control of silt and other pollutants during construction. CIRIA Report C532, Control of water pollution from construction sites, provides further guidance on this.
- 1.2 The Contractor will maintain the proposed drainage system during construction and until the handing over of the site.
- 1.3 Upon completion management of the shared drainage facilities (where not adopted) will be passed on to a Management Company appointed by the Developer on behalf of the Residents.
- 1.4 In the event that the Management Company becomes unable to discharge its duties within two years of first appointment the Developer will endeavour to appoint an alternative on behalf of the Residents.
- 1.5 Maintenance of individual property drainage connections is the responsibility of the individual property owners.
- 1.6 The following maintenance schedule details the typical tasks to be undertaken at different intervals.

Maintenance Schedule	Required Action	Frequency
Regular Maintenance	Manage vegetation and remove nuisance plants – aesthetics	As required
	Litter and debris removal – catchpits and gulleys	Monthly or as required
	Remove sediment and debris from silt trap chambers, channel drains and inlet chambers	6 monthly
	Visual inspection of permeable paving for defects and settlement	Annually
	Sweeping / brushing of permeable paving	Every 2 years
	Surface and foul water pipework – jetting / rodding	Every 2 years or as required
	Remove silt and debris from oil interceptors where provided	When alarm indicates



Maintenance Schedule	Required Action	Frequency
Corrective Maintenance	Remove debris / blockages to silt traps / channel drains	As required
	Repairs to access chambers / manhole covers	As required
	Replace any broken permeable blocks / surface, remedial works to any depressions or rutting	As required
	Inspect inlet, outlet from downpipes and gullies for blockages, standing water and clear	As required

Indicative Schedule of Maintenance for the Proposed Drainage System

2 Financing

- 2.1 The regular maintenance of all private drainage, channels, gutters, rainwater pipes and connections will be the responsibility of the individual property owners.
- 2.2 The regular and corrective maintenance of all shared elements of the drainage system will be managed and funded through the Management Company on behalf of the Residents.

Inspection / Action Required	Gullies, Channels and Gutters	Catchpits	Permeable Surface	Surface Water Pipework
6 Months	✓	✓	✓	
1 Year			✓	
After leaf fall in Autumn	✓	✓		
2 Years				✓

Drainage System Maintenance Summary